

DESIGN OF PUSHBUTTON ELECTRONIC OTHELLO BOARD

ANALYSIS OF FAILURE OF 1999 RADICA POCKET OTHELLO

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

The integration of technology into traditional games poses a profound sociotechnical challenge by necessitating a balanced configuration of technological advancement with proper consideration of the social and cultural dimensions of the gameplay. As an example, digitizing chess or adding AI opponents to Othello, demands a careful balance between current technology, culture, user experience and economics. This goes well beyond adopting the proper technology, requiring a comprehensive understanding of its broader societal, cultural, and user context.

In this paper, I propose an electronic Othello board that aims at enhancing the Othello gaming experience while preserving the classic setup and the social interactions it originally fosters. The design achieves this goal by integrating electronics to streamline manual gameplay steps and introduce a single-player mode while maintaining the traditional appearance of the board. Success of this design requires a comprehensive understanding of various sociotechnical factors, including technological constraints, user experience, social dynamics, cultural significance, and economic implications associated with this game. To bring a holistic analysis of these factors into the project's STS framework, I will employ the Actor-Network Theory. By analyzing the failure of the 1999 Radica Pocket Othello, a device that utilized electronics and software to transform classic 2-player Othello into a single-player handheld game, I will focus on how this innovation overemphasized technology while neglecting the intricate network of users, game tradition, and cultural elements that form a complex sociotechnical landscape.

I am arguing that neglecting these factors would result in a technically successful design that overlooks crucial aspects such as culture, customer, and the preservation of game tradition, and it will potentially disrupt the traditional game culture and disregarding user experiences. Below, I will

present my technical proposal to enhance modern Othello games, followed by an STS project investigation into how the 1999 Radica Pocket Othello's oversight of social and cultural factors contributed to its design failure. Through this analysis of the intricate network of sociotechnical elements, I aim to gain insights that will inform my technical project, focused on harmonizing the classic and modern Othello gaming experiences.

Technical Proposal

Othello is a renowned two-player board game for its intellectual challenge and suitability for social gatherings. Players take turns placing discs, each with one black and one white side, on an 8x8 grid. The objective is to capture and flip the opponent's pieces by strategically surrounding them with your own, with the goal of having the most of your color on the board when the game concludes.

Classic Othello poses unique challenges for both pros and newcomers. The physical setup of a board necessitates in-person practice, which poses a challenge for professionals needing frequent training with equally skilled peers, especially when they are located in different countries. Manual piece-flipping and complex rule dynamics, while enriching gameplay, can be barriers to entry and success of newcomers.

To address the shortcoming of the classic game board, a number of new Othello gaming platforms have been introduced. In 1999, Radica introduced a handheld pixel Othello game device ("Radica Games," 2012). Besides supporting single-player mode, this product automated the disc-flipping and enforced rules for valid piece placement. Users also have the flexibility to select their preferred difficulty level. At this stage, the game is better suited for regular players because even the hardest difficulty level was susceptible to defeat by skilled professionals. The Othello program on

these devices only employed shallow brute force search trees to plan its strategy (Wright, n.d.). The game underwent another evolution decades later where it transformed into a single program featuring vibrant visual displays on personal computers. With advancements in artificial intelligence and improved search and decision algorithms (Cirasella & Kopec, 2006), these programs can now foresee up to 10 steps ahead (Kling et al., 2018), making it impossible for human players to secure victory. A notable illustration of this progress is Mohammad Fahim Tajwar's online Othello game (Tajwar, n.d.), where AI algorithms, each governed by distinct strategic logics, to provide valuable insights for professional players.

However, as the game evolves, it has moved further away from the traditional board game, and transitioned into an automated yet over-simplified visual representation of the board's state. Users may struggle to attain the immersive experience provided by a physical board, and in some cases, 2-player mode support is even omitted. The relentless pursuit of strong AI and optimal play, sometimes neglects user experience. Imagine being a newcomer to Othello, playing against a formidable AI online and losing every single game—such an experience may potentially diminish one's enjoyment of the game.

The goal of this technical project is to integrate technology into Othello gameplay while preserving its traditional board setup by designing a board with an 8x8 grid of RGB LED push buttons replacing traditional pieces. The board integrates electronics to supports both single and 2-player modes, featuring an embedded AI program with selectable difficulty levels. It will also include automatic board state updates and move highlighting with LED pushbuttons for an enhanced gaming experience. These features harmonize the best of both classic and modern Othello, making

the product ideal for sparking interest among new players, social play with friends, and professional skill development.

Realization of the design requires a seamless integration of mechanical, electronic and software design. The board's outer housing and push buttons will be customized in CAD software and fabricated using 3D printing technology. When a button is pushed, it triggers one of the embedded 8x8 switch matrices on a printed circuit board below. A Raspberry Pi microprocessor identifies the real-time location of the pressed button (Pickering Interfaces Ltd., n.d.). It also controls RGB programmable LED strips to update the board's state in colored lighting (Rembor, n.d.). Additionally, an advanced AI Othello algorithm is embedded in the microprocessor, employing principal variation search (Runarsson & Jonsson, 2007), and various preliminary heuristics for exploring optimal moves (Gangwar et al., 2019), with an adjustable searching depth to match different difficulty levels (Runarsson & Jonsson, 2007).

Before implementing the project, various external considerations must be addressed. We would consider the availability or producibility of all necessary parts from electronic suppliers. Electrical connections must adhere to regulations to prevent electric hazards. A critical part of the project is the integration of LEDs and push buttons with Printed Circuit Board, which follows IPC-2221 standards ("IPC-2221A," 2003). In alignment with our project values, we will conduct surveys among our target user groups, ranging from newcomers to professional players, to gather their insights for enhancing immersive gaming experience.

STS Proposal

In 1999, Radica introduced its 'Pocket Othello,' a handheld gaming device equipped with a monochrome LCD screen to display the traditional game board and adopted control buttons for placing game discs, reset and displaying hint. This product aimed to distill the traditional Othello into a compact, portable device. The 'Pocket Othello' employed an embedded computer program that acted as the user's AI opponent, offering three skill levels to challenge players against opponents of varying expertise. This product marked a significant departure from the conventional notion of a 2-player game and transformed to an intellectual challenge and a source of leisure for individual users. At the time of its introduction, the company held a leading position in the handheld gaming industry with a 50 million global fan base ("Radica: Company," 1999). However, the new product failed to capitalize on the company's widespread popularity, and its sales consistently underperformed. This trend persisted until 2001 when the product ceased production. Today, it remains a rare find, with only a handful available from select eBay sellers who have preserved this vintage device for two decades.

The failures were typically attributed to the increased availability of multifunctional gaming options, including personal computers, as well as the presence of competing products like the Nintendo All-in-One console ("Nintendo," n.d.). From the users' perspective, the single-function device with its small, monochrome screen often appeared inferior when compared to the more sophisticated, all-in-one gaming platforms. However, such argument solely ascribe failure to ~~it's~~ the physical design shortcomings of the Pocket Othello. They inappropriately assumed that game designers could expand their user base simply by incorporating new technology, and oversimplify the complex dynamics at play.

Instead, we must also apply a more comprehensive evaluation. For example, we must acknowledge the significant role played by the targeted user groups, whose intention to use Othello as a means of social interaction with friends and family was disrupted by developer's decision to support only single-player mode. Nostalgia for traditional gaming setup may also factor into this equation which explains the reason classic game boards remain readily available on online marketplaces like Amazon, with over 40 million sets sold worldwide to date ("Othello Academy," n.d.). To avoid design failures like the Pocket Othello, it is crucial to recognize that users possess the ability to make choices and adapt technology according to their own judgment and objectives.

Therefore, I contend that the failure of Radica Pocket Othello should not be simplistically ascribed to its outdated and less appealing design compared to competing products. Rather, this failure is a product of a multifaceted interplay of human and non-human factors, encompassing user preferences, market trends, technological limitations, and developer decisions. Employing Actor-Network Theory (ANT) presents an opportunity for a more intricate examination of this issue. This framework looks at "science and technology in the making" by treating it as a complex network of heterogenous actors, including human and non-human, assembled by the network builders, and evaluates how the interactions and relationship between these actors contributes to a network's outcome. From an STS point of view, scholars treat engineers and scientists, the network builders, as primary actors to follow and evaluate throughout the process of network construction (Cressman, 2009). This framework allows for a holistic exploration of how these factors ~~combine~~ form a network which contribute to the failure of Radica Pocket Othello and the extent to which each element has influenced the network's design and ultimate outcome. This analysis would also provide invaluable insights for our upcoming technical design project, enabling us to identify and consider the crucial

factors that must be taken into account in order to create a successful design. To enhance the analysis, I will use user manuals for the 1999 Radica Pocket Othello and competing products, interview Othello players, and review reports on technology and the gaming market from that era.

Conclusion

The deliverables in the technical problem in the paper presents a technical design of an electronic Othello board that adheres to the traditional board setup while integrating software to elevate the user playing experience. This design and schematics would be explained in detail. The STS analysis employs Actor-Network Theory to illustrate the consequences of neglecting social and cultural factors in integrating technology in traditional gaming by examining how this negligence contributed to the failure of the 1999 Radica Pocket Othello. The combined result of the technical and STS problems would present an Othello game board with proper consideration of the balance between the social and technological aspects of gameplay. This also would lead to a detailed evaluation of all the sociotechnical actors, spanning from user to product developer, aiming to discuss how to effectively integrate technology into gameplay.

References

- Cirasella, J., & Kopec, D. (2006). The history of computer games. CUNY Academic Works (2006 ed.). City University of New York.
https://academicworks.cuny.edu/cgi/viewcontent.cgi?article=1181&context=gc_pubs
- Cressman, D. (2009) A brief overview of actor-network theory: punctualization, heterogeneous engineering & translation. summit research repository (2009 e.d.) Simon Fraser University.
<https://summit.sfu.ca/item/13593>
- Gangwar, P., et al. (2019). Hardware/software co-design of a high-speed Othello solver. 2019 *IEEE 62nd International Midwest Symposium on Circuits and Systems (MWSCAS)* (pp. 1223-1226). <https://doi.org/10.1109/MWSCAS.2019.8885136>
- IPC-2221 Task Group. (2003). Generic standard on printed board design. Retrieved Oct, 12, 2023, from <https://www.ipc.org/TOC/IPC-2221A.pdf>
- Kling, A. (2018, April 5). My Othello Career. Econlib.
https://www.econlib.org/archives/2011/02/my_othello_care.html
- Radica: Company. (1999). Internet Archive.
<https://web.archive.org/web/20010406031119/http://www.radicagames.com/company/aboutcom.htm>
- Radica Games 20Q Instruction Manual. (2012, May 12). ManualsLib.
<https://www.manualslib.com/manual/136904/Radica-Games-20q.html>
- Rembor, K. (n.d.). Getting started with Raspberry Pi Pico and CircuitPython. Adafruit Learning System. <https://learn.adafruit.com/getting-started-with-raspberry-pi-pico-circuitpython/neopixel-leds>

Runarsson, T. P., & Jonsson, E. O. (2007). Effect of Look-Ahead Search Depth in Learning Position Evaluation Functions for Othello Using ϵ -Greedy Exploration. *2007 IEEE Symposium on Computational Intelligence and Games* (pp. 210-215). <https://doi.org/10.1109/CIG.2007.368100>

List of Nintendo systems. (n.d.). Nintendo Wiki.

https://nintendo.fandom.com/wiki/List_of_Nintendo_systems

Mattel. (1999). CPY document - Pocket Othello.

https://service.mattel.com/instruction_sheets/I8042.pdf

Othello Academy. (n.d.). Trivia. <https://othelloacademy.weebly.com/trivia.html>

Tajwar, M. F. (n.d.). Othello Game AI [Online Game]. <https://othello-game-ai.netlify.app/>

Understanding tree and crosspoint matrix architectures. (n.d.). Pickering.

<https://www.pickeringtest.com/de-de/kb/hardware-topics/switching-architectures/understanding-tree-and-crosspoint-matrix-architectures> (Accessed on October 9, 2024)

Wright, E. (n.d.). Another new game from computing... Othello. *Creative Computing Magazine*.

Artiarchives.org. <https://www.atariarchives.org/bcc3/showpage.php?page=258>